

NATIONAL BUREAU OF STANDARDS REPORT

6429

INTERLABORATORY INTERCOMPARISONS

OF

96-INCH T12 COOL-WHITE FLUORESCENT LAMPS

Photometry and Colorimetry Section
Optics and Metrology Division



U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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by

Velma I. Burns
Photometry and Colorimetry Section
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U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

INTERLABORATORY INTERCOMPARISONS
of
96-INCH T12 COOL-WHITE FLUORESCENT LAMPS

by Velma I. Burns

Abstract

A group of ten 96-inch T12 cool white fluorescent lamps were measured in each of six laboratories. Luminous flux, lamp voltage, and lamp current were measured while holding the input power constant at 75 watts. The same lamp characteristics were measured again while holding the input voltage constant at 625 volts. The deviation of the average reported by each laboratory from the average of all laboratories for each of the measured quantities, the range of averages, the standard deviation of the values reported, and the standard error of the mean are given for each quantity measured.

I. Introduction

This intercomparison was undertaken to determine the uniformity of measurements on 96-inch cool white fluorescent lamps made at the participating laboratories. The laboratories participating and the order of reading are as follows:

- I General Electric Company
- II Interlectric Corporation
- III Sylvania Electric Products
- IV Champion Lamp Works
- V Westinghouse
- VI Duro Test

The order in which the laboratories made their measurements was chosen to reduce shipment of the lamps as much as possible. Each laboratory followed its own customary procedure in making the measurements. Two lamps were broken during shipment so that Duro Test was able to measure only eight of the lamps.

II. Results of Measurements

The values reported by each laboratory and an analysis of the results are given in tables 1 through 9.

Table 1

Luminous Flux in Lumens

Lamps operated at 75 watts

Lamp No.	GE	Inter	Syl	Champ	West	Duro	Ave.
ECX-1	4998	4975	5084	4884	5004	5088	5006
ECX-2	4928	4915	5000	4912	4929	4950	4939
ECX-3	4936	4865	4964	4944	4896	4944	4925
ECX-4	4901	4765	4876	4840	4902	4892	4863
ECX-5	4706	4830	4752	4780	4747	4766	4764
ECX-6	4800	4760	4772	4764	4768	4756	4770
ECX-7	4922	4905	5004	4916	4966		4943
ECX-8	4772	4790	4800	4800	4784	4816	4794
ECX-9	4584	4730	4608	4676	4612	4628	4640
ECX-10	4954	4950	4988	4964	4940		4959
Ave. of 10	4850	4848	4885	4848	4855		4857
Ave. of 8	4828	4829	4857	4825	4830	4855	4837
							Average for the 10 lamps 4860
Deviation from average %	-.20	-.25	+.51	-.25	-.10	+.37	
Range of averages reported							.76%
Standard deviation of the values reported							.89%
Standard error of the mean							.12%

Table 2

Luminous Flux in Lumens

Lamps operated at 625 line volts

Lamp No.	GE	Inter	Syl	Champ	West	Duro	Ave.
ECX-1	4994	4945	5128	4928	4960	5060	5002
ECX-2	4961	4930	5048	4952	4916	5024	4972
ECX-3	4962	4900	5060	4940	4927	5036	4971
ECX-4	4913	4870	4932	4868	4846	4940	4895
ECX-5	4705	4835	4804	4720	4641	4812	4753
ECX-6	4800	4755	4852	4752	4703	4852	4786
ECX-7	4876	4895	5016	4900	4853		4908
ECX-8	4795	4805	4856	4812	4730	4864	4810
ECX-9	4578	4730	4642	4608	4519	4668	4624
ECX-10	5007	4930	5048	4928	4923		4967
Ave. of 10	4859	4860	4939	4840	4802		4860
Ave. of 8	4838	4846	4915	4822	4780	4907	4851
			Average for the 10 lamps				4869
Deviation from average %	-.21	-.18	+1.4	-.60	-1.4	+1.2	
Range of averages	2.8%						
Standard deviation of the values reported	1.28%						
Standard error of the mean	.17%						

Lamp No.	GE	Inter	Syl	Champ	West	Duro	Ave.
ECX-1	66.6	66.3	67.8	65.1	66.7	67.8	66.7
ECX-2	65.7	65.5	66.7	65.6	65.7	66.0	65.9
ECX-3	65.8	64.9	66.1	65.9	65.3	65.9	65.6
ECX-4	65.3	63.5	65.0	64.6	65.4	65.3	64.8
ECX-5	62.7	64.4	63.4	63.7	63.3	63.4	63.5
ECX-6	64.0	63.5	63.6	63.6	63.6	63.4	63.6
ECX-7	65.6	65.4	66.7	65.6	66.2		65.9
ECX-8	63.6	63.9	64.0	64.0	63.8	64.2	63.9
ECX-9	61.1	63.1	61.4	62.3	61.5	61.7	61.8
ECX-10	66.0	66.0	66.5	66.2	65.9		66.1
Ave. of 10	64.7	64.6	65.1	64.6	64.7		64.7
Ave. of 8	64.4	64.4	64.8	64.4	64.4	64.7	64.5
Average of the 10 lamps							64.8
Deviation from average %	-.15	-.31	+.46	-.31	-.15	+.31	
Range of averages reported			.77%				
Standard deviation of the values reported				.89%			
Standard error of the mean			.12%				

Lamp No.	GE	Inter	Syl	Champ	West	Duro	Ave.
ECX-1	66.5	65.2	67.9	65.7	66.9	66.8	66.5
ECX-2	65.5	65.0	66.7	66.0	66.3	66.2	66.0
ECX-3	65.5	63.8	66.1	65.6	65.3	66.4	65.4
ECX-4	65.6	63.4	64.9	65.7	65.6	65.2	65.1
ECX-5	62.5	63.0	63.5	63.7	63.5	63.4	63.3
ECX-6	63.8	62.7	63.8	63.7	63.8	63.8	63.6
ECX-7	65.9	65.0	66.8	66.2	66.5		66.1
ECX-8	63.3	62.4	64.1	64.7	64.0	64.3	63.8
ECX-9	61.4	62.4	61.4	63.5	61.6	61.7	62.0
ECX-10	66.2	65.1	66.4	66.3	66.7		66.1
Ave. of 10	64.6	63.8	65.2	65.1	65.0		64.7
Ave. of 8	64.3	63.5	64.8	64.8	64.6	64.7	64.4
							Average of the 10 lamps
Deviation from average %	-.31	-1.5	+.62	+.46	+.31	+.46	
Range of averages reported			2.1%				
Standard deviation of the values reported				1.15%			
Standard error of the mean			.15%				

Table 5

Lamp Current in Milliamperes

Lamps operated at 75 watts

Lamp No.	GE	Inter	Syl	Champ	West	Duro	Ave.
ECX-1	422	415	418	417	427	415	419
ECX-2	420	410	418	418	428	416	418
ECX-3	420	410	412	420	418	414	416
ECX-4	424	410	417	420	432	417	420
ECX-5	426	413	418	430	439	418	424
ECX-6	426	421	417	423	432	414	422
ECX-7	432	422	423	422	437		427
ECX-8	421	411	415	419	430	416	419
ECX-9	423	417	413	428	433	417	422
ECX-10	419	418	415	420	431		421
Ave. of 10	423	415	417	422	431		422
Ave. of 8	423	413	416	422	430	416	420
Average for the 10 lamps							420
Deviation from average %	+ .71	-1.2	-.71	+.48	+2.6	-.95	
Range of averages reported	3.8%						
Standard deviation of the values reported	1.60%						
Standard error of the mean	.21%						

Table 6

Lamp Current in Milliampères

Lamps operated at 625 line volts

Lamp No.	GE	Inter	Syl	Champ	West	Duro	Ave.
ECX-1	422	423	423	420	421	422	422
ECX-2	422	424	423	420	422	422	422
ECX-3	422	422	422	420	421	423	422
ECX-4	424	423	423	421	421	423	422
ECX-5	426	425	424	423	425	424	424
ECX-6	422	428	424	420	424	423	424
ECX-7	425	426	424	421	424		424
ECX-8	424	424	422	421	423	423	423
ECX-9	420	421	419	418	421	420	420
ECX-10	424	426	423	421	423		423
Ave. of 10	423	424	423	420	422		422
Ave. of 8	423	424	422	420	422	422	422
			Average for the 10 lamps				423
Deviation from average %	0	+.24	0	-.71	-.24	0	
Range of averages reported			.95%				
Standard deviation of the values reported				.36%			
Standard error of the mean			.05%				

Table 7

Lamp Volts

Lamps operated at 75 watts

Lamp No.	GE	Inter	Syl	Champ	West	Duro	Ave.
ECX-1	197	199	201	196.2	197	204	199
ECX-2	198	202	202	196.2	198	203	200
ECX-3	198	202	204	192.0	201	205	200
ECX-4	197	202	202	193.8	196	202	199
ECX-5	195	201	201	190.2	193	201	197
ECX-6	197	197	202	194.0	196	204	198
ECX-7	193	197	200	192.0	193		195
ECX-8	198	202	202	192.4	196	204	199
ECX-9	198	201	205	191.4	197	205	200
ECX-10	199	199	203	190.0	196		197

Ave. of 10 197 200 202 192.8 196 198

Ave. of 8 197 201 202 193.3 197 204 199

Average for the 10 lamps 198

Deviation from
average % -.51 +1.0 +2.0 -2.5 -1.0 +2.5

Range of averages reported 5.0%

Standard deviation of the values reported 2.11%

Standard error of the mean .28%

Date		Description		Amount		Balance	
1901	Jan 1	Balance					
1901	Jan 15	Received from A. B.					
1901	Feb 1	Received from C. D.					
1901	Feb 15	Received from E. F.					
1901	Mar 1	Received from G. H.					
1901	Mar 15	Received from I. J.					
1901	Apr 1	Received from K. L.					
1901	Apr 15	Received from M. N.					
1901	May 1	Received from O. P.					
1901	May 15	Received from Q. R.					
1901	Jun 1	Received from S. T.					
1901	Jun 15	Received from U. V.					
1901	Jul 1	Received from W. X.					
1901	Jul 15	Received from Y. Z.					
1901	Aug 1	Received from A. B.					
1901	Aug 15	Received from C. D.					
1901	Sep 1	Received from E. F.					
1901	Sep 15	Received from G. H.					
1901	Oct 1	Received from I. J.					
1901	Oct 15	Received from K. L.					
1901	Nov 1	Received from M. N.					
1901	Nov 15	Received from O. P.					
1901	Dec 1	Received from Q. R.					
1901	Dec 15	Received from S. T.					
1901	Dec 31	Received from U. V.					

Total Received
 Total Paid
 Balance Forward

Lamp No.	GE	In ter	Syl	Champ	West	Duro	Ave.
ECX-1	197	198	200	196.0	198	202	198
ECX-2	198	200	201	197.8	197	202	199
ECX-3	197	200	203	192.4	201	203	199
ECX-4	195	200	201	194.6	197	202	198
ECX-5	196	200	200	192.4	194	202	197
ECX-6	197	196	202	195.2	197	202	198
ECX-7	194	196	199	192.0	194		195
ECX-8	197	201	202	193.0	197	202	199
ECX-9	199	200	204	193.2	198	202	199
ECX-10	197	199	202	191.0	197		197
Ave. of 10	197	199	201	193.8	197		198
Ave. of 8	197	199	202	194.3	197	202	199
Average for the 10 lamps							198
Deviation from average %	-.51	+.51	+1.5	-2.0	-.51	+1.5	
Range of averages reported			3.5%				
Standard deviation of the values reported				1.68%			
Standard error of the mean			.22%				

Table 9

Watts

Lamps operated at 625 line volts

Lamp No.	GE	Inter	Syl	Champ	West	Duro	Ave.
ECX-1	75.1	75.8	75.5	75.0	74.13	75.7	75.2
ECX-2	75.7	75.9	75.7	75.0	74.13	75.9	75.4
ECX-3	75.7	76.8	76.5	75.4	75.5	75.9	76.0
ECX-4	74.9	76.8	76.0	74.2	73.9	75.8	75.3
ECX-5	75.3	76.7	75.7	74.2	73.13	75.9	75.2
ECX-6	75.2	75.8	76.0	74.8	73.73	76.1	75.3
ECX-7	74.0	75.3	75.1	74.0	73.0		74.3
ECX-8	75.7	77.0	75.7	74.4	73.9	75.7	75.4
ECX-9	74.6	75.8	75.6	72.6	73.33	75.7	74.6
ECX-10	75.6	75.7	76.0	74.4	73.86		75.1
Ave. of 10	75.2	76.2	75.8	74.4	73.86		75.1
Ave. of 8	75.3	76.3	75.8	74.4	73.97	75.8	75.3
Average of the 10 lamps							75.2

Deviation from
average % 0 +1.3 +.80 -1.1 -1.8 +.66

Range of averages reported 3.1%

Standard deviation of the values reported 1.32%

Standard error of the mean .17%

THE HISTORY OF THE

Year	Month	Day	Event	Location	Notes
1776	July	4	Declaration of Independence	Philadelphia	
1776	September	26	British evacuated Philadelphia	Philadelphia	
1777	September	26	British evacuated Philadelphia	Philadelphia	
1777	October	4	British evacuated Philadelphia	Philadelphia	
1777	November	20	British evacuated Philadelphia	Philadelphia	
1777	December	19	British evacuated Philadelphia	Philadelphia	
1778	January	3	British evacuated Philadelphia	Philadelphia	
1778	February	15	British evacuated Philadelphia	Philadelphia	
1778	March	27	British evacuated Philadelphia	Philadelphia	
1778	April	19	British evacuated Philadelphia	Philadelphia	
1778	May	25	British evacuated Philadelphia	Philadelphia	
1778	June	26	British evacuated Philadelphia	Philadelphia	
1778	July	27	British evacuated Philadelphia	Philadelphia	
1778	August	28	British evacuated Philadelphia	Philadelphia	
1778	September	29	British evacuated Philadelphia	Philadelphia	
1778	October	30	British evacuated Philadelphia	Philadelphia	
1778	November	1	British evacuated Philadelphia	Philadelphia	
1778	December	2	British evacuated Philadelphia	Philadelphia	
1778	January	3	British evacuated Philadelphia	Philadelphia	
1778	February	4	British evacuated Philadelphia	Philadelphia	
1778	March	5	British evacuated Philadelphia	Philadelphia	
1778	April	6	British evacuated Philadelphia	Philadelphia	
1778	May	7	British evacuated Philadelphia	Philadelphia	
1778	June	8	British evacuated Philadelphia	Philadelphia	
1778	July	9	British evacuated Philadelphia	Philadelphia	
1778	August	10	British evacuated Philadelphia	Philadelphia	
1778	September	11	British evacuated Philadelphia	Philadelphia	
1778	October	12	British evacuated Philadelphia	Philadelphia	
1778	November	13	British evacuated Philadelphia	Philadelphia	
1778	December	14	British evacuated Philadelphia	Philadelphia	
1778	January	15	British evacuated Philadelphia	Philadelphia	
1778	February	16	British evacuated Philadelphia	Philadelphia	
1778	March	17	British evacuated Philadelphia	Philadelphia	
1778	April	18	British evacuated Philadelphia	Philadelphia	
1778	May	19	British evacuated Philadelphia	Philadelphia	
1778	June	20	British evacuated Philadelphia	Philadelphia	
1778	July	21	British evacuated Philadelphia	Philadelphia	
1778	August	22	British evacuated Philadelphia	Philadelphia	
1778	September	23	British evacuated Philadelphia	Philadelphia	
1778	October	24	British evacuated Philadelphia	Philadelphia	
1778	November	25	British evacuated Philadelphia	Philadelphia	
1778	December	26	British evacuated Philadelphia	Philadelphia	
1778	January	27	British evacuated Philadelphia	Philadelphia	
1778	February	28	British evacuated Philadelphia	Philadelphia	
1778	March	29	British evacuated Philadelphia	Philadelphia	
1778	April	30	British evacuated Philadelphia	Philadelphia	
1778	May	31	British evacuated Philadelphia	Philadelphia	
1778	June	1	British evacuated Philadelphia	Philadelphia	
1778	July	2	British evacuated Philadelphia	Philadelphia	
1778	August	3	British evacuated Philadelphia	Philadelphia	
1778	September	4	British evacuated Philadelphia	Philadelphia	
1778	October	5	British evacuated Philadelphia	Philadelphia	
1778	November	6	British evacuated Philadelphia	Philadelphia	
1778	December	7	British evacuated Philadelphia	Philadelphia	
1778	January	8	British evacuated Philadelphia	Philadelphia	
1778	February	9	British evacuated Philadelphia	Philadelphia	
1778	March	10	British evacuated Philadelphia	Philadelphia	
1778	April	11	British evacuated Philadelphia	Philadelphia	
1778	May	12	British evacuated Philadelphia	Philadelphia	
1778	June	13	British evacuated Philadelphia	Philadelphia	
1778	July	14	British evacuated Philadelphia	Philadelphia	
1778	August	15	British evacuated Philadelphia	Philadelphia	
1778	September	16	British evacuated Philadelphia	Philadelphia	
1778	October	17	British evacuated Philadelphia	Philadelphia	
1778	November	18	British evacuated Philadelphia	Philadelphia	
1778	December	19	British evacuated Philadelphia	Philadelphia	
1778	January	20	British evacuated Philadelphia	Philadelphia	
1778	February	21	British evacuated Philadelphia	Philadelphia	
1778	March	22	British evacuated Philadelphia	Philadelphia	
1778	April	23	British evacuated Philadelphia	Philadelphia	
1778	May	24	British evacuated Philadelphia	Philadelphia	
1778	June	25	British evacuated Philadelphia	Philadelphia	
1778	July	26	British evacuated Philadelphia	Philadelphia	
1778	August	27	British evacuated Philadelphia	Philadelphia	
1778	September	28	British evacuated Philadelphia	Philadelphia	
1778	October	29	British evacuated Philadelphia	Philadelphia	
1778	November	30	British evacuated Philadelphia	Philadelphia	
1778	December	31	British evacuated Philadelphia	Philadelphia	

THE HISTORY OF THE
DECLARATION OF INDEPENDENCE
OF THE UNITED STATES OF AMERICA
BY
JAMES OSGOOD
NEW YORK: PUBLISHED BY
J. B. LIPPINCOTT & CO., 15 N. 4TH ST.
1876.

Table 10

Standard Error of the Mean

Quantity measured	75 watts set	625 volts set
lumens	.12	.17
lumens per watt	.12	.15
lamp current	.21	.05
lamp volts	.28	.22
watts		.17

III. Conclusions

The results show that the participating laboratories are in very good agreement on measurements on this type and size of lamp. Table 10 shows that except for the measurement of lamp current there is no significant difference in the agreement among the laboratories whether lamp watts are set or line voltage is set.

U. S. DEPARTMENT OF COMMERCE

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NATIONAL BUREAU OF STANDARDS

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THE NATIONAL BUREAU OF STANDARDS

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Optics and Metrology. Photometry and Colorimetry. Optical Instruments. Photographic Technology. Length. Engineering Metrology.

Heat. Temperature Physics. Thermodynamics. Cryogenic Physics. Rheology. Engine Fuels. Free Radicals Research.

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